469

R06 FHP

1965 BURNS PROJECT

Douglas-fir Tussock Moth Control

MALHEUR AND OCHOCO NATIONAL FORESTS

By:
Randall F. Perkins
and
Robert E. Dolph, Jr.

COVER: Spraying in the Antelope Mountain Unit.

OPERATIONAL AND ENTOMOLOGICAL REPORT

1965 BURNS PROJECT

DOUGLAS-FIR TUSSOCK MOTH CONTROL

by

Randall F. Perkins
Forester

and

Robert E. Dolph, Jr.
Entomologist

March 1967

Insect and Disease Control Branch
Division of Timber Management

Pacific Northwest Region — Forest Service

U. S. Department of Agriculture

CONTENTS

	Page
INTRODUCTION	1
BACKGROUND	2
EVALUATION	3
PREPARATION	4
OPERATION	5
Personnel and Equipment	5
Contracts	6
Release of Spray Blocks	6
Spraying	9
Spray Distribution	11
Mortality	11
Map	12
COOPERATION	14
RESULTS	14
RECOMMENDATIONS	16
BIBLIOGRAPHY	16
APPENDIX	17

INTRODUCTION

An all-out attack was waged during the summer of 1965 against the voracious Douglas-fir tussock moth which threatened defoliation of large areas of true firs and Douglas-fir within and adjacent to the Malheur and Ochoco National Forests in eastern Oregon.

The largest all-helicopter aerial insect spray project ever conducted by the U. S. Forest Service began on June 10 and was completed on July 1. A net total of 65,945 acres of Federal, State, and private lands were sprayed with DDT, applied at the rate of 3/4-pound in one gallon of fuel oil per acre.

Insect mortality checks made ten days after spraying indicated that insect kill exceeded 98 percent. Further checks in the fall of 1965 showed that a virus infection had completely eliminated the remaining tussock moth population.

Extensive stands of young growth were defoliated during 1964.

BACKGROUND

The Douglas-fir tussock moth *(Hemerocampa pseudotsugata* McD.) is one of the most destructive defoliators of true firs and Douglas-fir in western North America.

In 1929-30 the tussock moth killed 300 million board feet of timber on the Colville National Forest in northeastern Washington. In 1946-47 the largest known attack by this timber killer hit 500,000 acres in northern Idaho, northeastern Oregon and eastern Washington. Nearly 2 billion board feet of fir timber were threatened before the biggest forest spray project undertaken up to that time brought the infestation under control. DDT was used and control was achieved with little or no known side effects to resources in the area.

On the Burns Project, only 15 acres were involved when this insect infestation was first detected in 1963. By 1964, the attack had grown to epidemic proportions involving more than 50,000 acres. It was predicted that if control was not achieved in 1965, the infestation could possibly cover 200,000 acres.

The Malheur National Forest, where most of the attack was concentrated, has an annual allowable cut of 171 million board feet, the largest timber harvest of any eastside National Forest in the Pacific Northwest Region. Most of the mills in the area are dependent on National Forest timber, with milling capacity far greater than the timber available. Any loss of timber would result in a serious blow to the local economy.

Edward Hines Lumber Company complex at Hines, Oregon, including recently installed plywood mill designed to utilize the true firs and Douglas-fir threatened by the tussock moth.

By fall of 1964, the tussock moth had killed immature timber on 1,950 acres and 2.6 million board feet of mature timber, totaling $219,000 in value.

Immediately threatened were 33,700 acres of young trees and 262.5 million board feet of mature timber, totaling $4.5 million in value.

Ultimately threatened, unless control was achieved in 1965, were 122,000 acres of immature timber, and 950 million board feet of mature timber, totaling $16.5 million in value. The worth to the local economy in manufactured value and payrolls would be several times this amount.

Generally, tussock moth outbreaks are brought under control rather quickly by parasites and a virus disease. However, this natural control does not occur until the late stages of larval development. By this time, most of the larval feeding is over and tremendous damage has occurred. Entomologists saw no chance of natural control in time to prevent widespread tree mortality in the case of the Burns Project.

Regional surveys have shown that similar infested stands could reasonably survive one defoliation but subsequent defoliation could cause widespread mortality. Since a good share of the Burns area had been defoliated once and some areas twice, a control effort was deemed necessary.

EVALUATION

The 1964 cooperative forest aerial survey recorded over 41,000 acres of true fir and Douglas-fir defoliated by the tussock moth on the Malheur and Ochoco National Forests. The epidemic occurred at five different locations: Antelope Mountain, Gold Hill, King Mountain, and Vance Creek on the Malheur National Forest and at Silver Springs on the Ochoco National Forest.

A biological evaluation made in the fall of 1964 indicated the trend was upward and biological agents were not sufficient to check the outbreaks before heavy losses would occur in 1965 (McComb 1965).

Egg mass surveys were made to determine the ratio of new egg masses to old ones — an accepted procedure for determining the trend of tussock moth infestations. Egg mass ratios varied from 1:1 in the smaller Gold Hill unit to 8:1 at King Mountain and 14:1 at Antelope Mountain — the latter two being the largest units.

Three of the units were sampled to determine the incidence of tussock moth virus. Examination of dead larvae showed an infection rate as follows: Antelope Mountain — 3 percent; King Mountain — 12 percent, and Gold Hill — 51 percent. Except possibly in the Gold Hill area, this level was, of course, deemed insufficient to stop the epidemic before serious damage occurred.

PREPARATION

In order to assure that all interested parties were aware of the problems in the Burns area, the Forest Service and the Northwest Forest Pest Action Council jointly invited interested individuals, organizations, and agencies to inspect the area. On October 8 and 9, 1964 a field trip was conducted in the area. Aerial flights were made over the infested area, an on-the-ground inspection was made, and a general discussion was held at a dinner meeting. Approximately 40 persons attended the field trip and/or dinner. People attending included representatives from trade associations, industry, and Federal, State and County agencies.

The Forest Service proposed a control project to the Northwest Forest Pest Action Council at their October 23, 1964 meeting. The proposal was to aerial spray approximately 50,000 acres with 3/4-pound of DDT dissolved in one gallon of fuel oil which was to be applied at the rate of one gallon per acre. The Council endorsed the Forest Service's proposed project. In addition, the project was endorsed by the Pacific Northwest Region Forest Advisory Council, the Malheur National Forest Advisory Council, the Malheur National Forest Grazing Advisory Board, the County Courts of Harney and Grant Counties, and the Harney County Chamber of Commerce.

Mountain meadows throughout the Project area provide intermittent grazing for about 4,500 head of cattle from adjacent ranches.

Final approval was received from the Federal Committee on Pest Control in March 1965. This Committee must, of course, approve all Federally financed aerial spray insect control projects in the United States.

Direct contact was made, either through meetings or correspondence, with the agencies or organizations listed in the appendix.

Because of the controversy concerning the use of DDT, the organizations and agencies mentioned were invited to participate in a cooperative surveillance program in connection with the Project. The purpose of the surveillance work was to detect and evaluate side effects, if any, on fish and wildlife, range cattle, soil, water purity, and public health. At the request of the Federal Committee on Pest Control, special emphasis was given to surveillance of the range and cattle resources as ranching is a primary industry in the Burns area. A considerable acreage of primary range was included within the exterior boundaries of the spray areas and little information is known concerning possible contamination of range resources when spraying adjacent timber stands.

A surveillance committee was formed which consisted of representatives from the following agencies:

Oregon State University

Departments of Agricultural Chemistry, and Fisheries and Wildlife Management

U. S. Forest Service

National Forest Administration

Divisions of Timber Management and Range and Wildlife Management, Malheur National Forest

Pacific Northwest Forest and Range Experiment Station

Division of Watershed Management Research

Division of Range, Wildlife and Recreation Management Research

U. S. Department of the Interior

Bureau of Sport Fisheries and Wildlife

State of Oregon

Game Commission

U. S. Agricultural Research Service

Entomology Research Division

A Forest Service scientist served as coordinator for the surveillance group.

Some studies conducted by the surveillance group are scheduled to run as long as three years. Most others are relatively short term. Final reports of the surveillance studies will be published by each of the several cooperators.

Information and education activities began in August 1964 as soon as it became apparent that the Burns Douglas-fir tussock moth infestation had reached epidemic proportions. An initial press release announced that a control project may be necessary in the spring of 1965 to avoid serious timber losses.

A formal information and education plan was prepared, designating specific assignments to be accomplished before, during, and after the Project. Personnel from the Forests and the Regional Office began an intensive effort to personally contact key groups and individuals, including timber operators, sportsmen and grazing permittees. Regional Forester Stone wrote to Senators Morse and Neuberger, and Congressman Ullman to describe the Project and to outline measures to protect other resources from side effects. A Project brochure, "Saving the Forests," was printed. Distribution was made throughout the Region, including news media and key individuals on the Multiple Use Highlights mailing list. Two portable pictorial exhibits were prepared to show the Project map, color photos of defoliation, and black and white pictures of the insect life cycle and helicopter spraying. One exhibit was sent to John Day for display in public buildings, and one was set up in the window of Project Headquarters at Burns. Copies of the Project brochure accompanied the exhibits for public distribution on a "help yourself" basis.

Press releases were made at timely intervals. The Oregon Journal, on May 22, 1965, ran an editorial implying support of the Project — "The Burns Tussock Moth Project appears to be a conscientious attempt to strike the needed balance between the values that can be saved by spraying and the damage that spray can cause other forms of life." In line with the information and education plan, a press kit was prepared for distribution to approximately 25 news media who might be interested in personal coverage of the Project.

As the starting spray date drew near, the Project was entirely free of public controversy.

Safety was considered a key factor in the conduct of the Project. A comprehensive safety plan was prepared to assist in carrying out the spray program with no fatalities, no lost time injuries, and no property damage accidents in either the Forest Service or contractor organization. Accident prevention and safety code compliance took precedence over immediate job production with safety always first.

OPERATION

Project Headquarters were established in Burns, Oregon on May 3, 1965. Signs were specially printed for Headquarters identification and to welcome visitors. The first Project personnel to occupy the quarters were the Project Entomologist, his assistant, and ten insect checkers. Their preliminary job was to establish observation plots at which insect development would be recorded, search out areas of infestation and necessary buffer strips for determination of final spray area boundaries, and other entomological duties (Perkins et al. 1965).

Several weeks later Headquarters were occupied by business management personnel — the administrative officer and two clerks. Telephones and radios were installed.

The Project was established as a subunit of the Malheur National Forest. Preliminary budgets were prepared and funds allocated to a special account set up by the Forest. During the Project all charges for contracts, salaries and travel, supplies, equipment use, and aircraft rental were made to this Forest account by Project personnel. The only charges not made to this account were salaries and travel of Regional Office personnel.

PERSONNEL AND EQUIPMENT

Thirty-two Forest Service personnel were employed during the peak of the operation. These included 4 assigned from the Regional Office, 19 assigned from the affected Forests (Malheur and

Ochoco), and 9 detailed from other Region 6 Forests. More than 11,000 man-hours were worked by Forest Service personnel.

More than 5,000 man-hours were worked by 20 or more contracting personnel — pilots, mechanics and truck drivers.

A total of 19 Forest Service vehicles were employed on the Project. Five of these were four-wheel drive jeeps which were indispensable because of numerous muddy roads, typical of early spring eastside forest roads.

CONTRACTS

Three contracts were let for the major phases of the Burns Project. These included (1) a contract for formulation, transportation and storage of insecticide, (2) another for insecticide application using six spray helicopters, and (3) one for two observation helicopters. Contracts were developed by the Forest Service with the assistance of specialists in the many technical, industrial, and aviation fields. Federal and State rules and regulations and safety requirements applicable to all phases of the control operation were determined and incorporated in the three different contracts.

The insecticide contract was awarded to the Lennington Corporation of Vancouver, Washington. The bid price was $0.58 per gallon of formulated insecticide. Significant features of this contract were:

1. Insecticide formulation was 3/4-pound of DDT dissolved in .94 quart of auxiliary hydrocarbon solvent and sufficient No. 2 fuel oil to make 1 gallon of solution at 60° Fahrenheit.

2. Estimated gallonage was 55,600 plus or minus 30 percent. A total of 67,022 gallons were actually ordered and used.

3. Contract placed no restriction on place of formulation.

4. Minimum storage facilities of 25,000 gallons were required at two locations — Burns and Summit Prairie, Oregon.

5. Contractor was required to formulate, deliver, and place insecticide in storage at the above locations.

6. Basis for payment was gallonage pumped into storage facilities.

7. Contractor's responsibility ended when insecticide was pumped from storage facilities into aerial spray contractor's tank trucks.

Twenty thousand gallons of insecticide were available at all times at storage facilities at Burns, Oregon.

The contract for aerial application of insecticide was awarded to Evergreen Helicopters, Inc., McMinnville, Oregon. The contract price was $1.85 per acre. Significant features of this contract were:

1. Aerial application of insecticide solution to 55,600 acres plus or minus 30 percent. Gross area was approximately 58,300 acres of which 2,700 acres were not to be sprayed. This non-spray area consisted of streams, mountain meadows, rocky outcrops, and other openings in the forest cover.

2. Provide transportation of spray solution from storage facilities at Burns and Summit Prairie, Oregon to operating heliports.

Insecticide was carefully metered into each aircraft. Maximum load permitted for each aircraft was 70 gallons.

Frequent adjustment of nozzles was necessary to assure uniform spray patterns.

3. Contractor to provide a minimum of six helicopters. Such helicopters to be equal or better in performance to Hiller 12E or Bell G-3.

4. Helicopters must be capable of carrying a minimum of 500 pounds of spray solution and a minimum capacity of 60 gallons.

5. Maximum load limits restricted to FAA certification, standard category.

6. Minimum boom length was 37 feet and equipped with flat atomizing teejet or equivalent nozzles with No. T-8003 orifice tips. Nozzles were spaced evenly along boom at intervals of 12 to 18 inches. Spray system was to operate at 40 to 50 p. s. i. boom pressure and deliver spray at the rate of 1 gallon per acre with a mass median diameter of not less than 100 microns nor more than 150 microns.

7. Effective swath width was considered to be 80 feet unless it could be conclusively demonstrated that a wider effective width was possible.

8. Application to be made at an airspeed of 45 miles per hour at 30 feet above ground cover.

9. No spraying was permitted within one-half swath width of any major fish bearing stream. In these areas flights were made parallel to the stream.

10. Six down days were allowed for the fleet of six helicopters without penalty. Thereafter, $600.00 per day liquidated damages were to be assessed for each down helicopter.

The contract for observation helicopters was awarded to Reeder Flying Service, Twin Falls, Idaho. The bid price was $104.00 per hour. Significant features of the contract were:

1. Helicopters were used for observation and administrative purposes over all five spray units of the Burns Project.

2. Contractor to furnish two helicopters equal or better in performance to Hiller 12E or Bell G-3.

3. Forest Service guaranteed 70 flight hours.

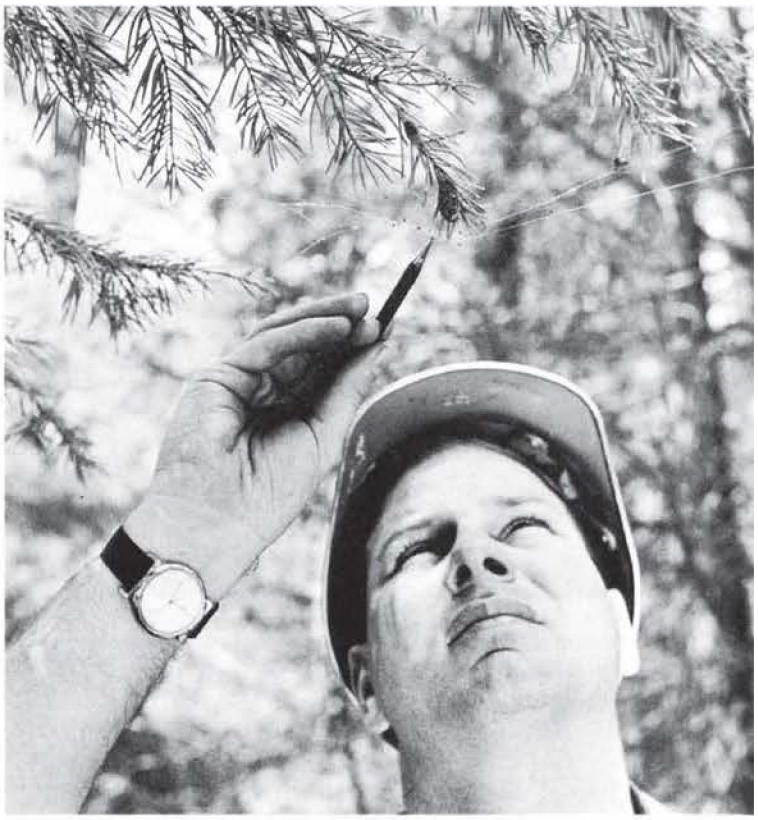
4. Two down days were allowed for the fleet of two aircraft before penalty. Thereafter, $400.00 per day liquidated damages were assessed for each down helicopter.

Constant observation assured orientation of spray aircraft, thereby providing adequate spray coverage and avoiding contamination of non-spray areas.

Observation plots were checked frequently to determine when each area was ready for spraying.

RELEASE OF SPRAY BLOCKS

The essence of this control Project was proper timing in releasing areas for spraying. The insecticide was applied soon after the majority of the tussock moth larvae had emerged from their egg mass and before heavy feeding occurred. To determine when egg hatch was general, 84 observation plots were established at various elevations throughout the five infestation centers. At each plot, a total of 25 egg masses — 5 each on 5 trees — were tagged. Each plot was visited three times a week. When 80 percent of the egg masses within the block had hatched, the block was released for spraying.



Project Entomologist Dolph inspecting newly hatched egg mass.

Entomologists determined rate of hatching of egg masses under controlled conditions at Project Headquarters for comparison with field conditions.

Individual spray block boundaries were altered during the Project because egg hatch varied with elevational and weather differences. The Vance Creek Unit, situated at 3,900 feet, was the first block released for spraying on June 10. The last block, Silver Springs Unit, located near 7,000 feet, was not released for spraying until June 30. Intermediate elevations were released at various dates as shown in the appendix.

During the Project, insect checkers scouted adjacent timber areas to assure inclusion of all infested areas and enlarge the buffer zone where needed. Over 10,000 acres were added to the Project for an approximate total of 66,000 acres.

One isolated spray block in the King Mountain Unit was set aside to test two new insecticides, Dursban and Zectran, provided by the Pacific Southwest Forest and Range Experiment Station (McComb 1966). This block was sprayed later in July after heavy feeding had occurred. This feeding damage was noticeable when compared with adjacent blocks sprayed earlier with DDT.

The preliminary estimate of acreage in need of spraying was 55,600. However, after intensive field searching by entomologists the total acreage was increased to 65,945. This increase included areas of very light infestations and adequate buffer zones. The final spray acreage by units was as follows:

Malheur National Forest

Antelope Mountain Unit	23,000
Gold Hill Unit	11,655
King Mountain Unit	27,334
Vance Creek Unit	661

Ochoco National Forest

Silver Springs Unit	3,295
Total Project acreage	65,945

The ownership of spray areas was as follows:

Private	1,887
State of Oregon	380
National Forest	63,678
Total Project acreage	65,945

Operations began each morning at about 5:30 — as soon as it was light enough for takeoff.

SPRAYING

Six spray helicopters, two observation helicopters and one Forest Service helicopter were employed on the Project. The Forest Service helicopter was utilized for both observation of spray application and administrative duties. In addition, a Forest Service Cessna 180 was used for training, reconnaissance and administrative duties.

Each contract helicopter initially reported to the Burns Airport for inspection. The Project aerial consultant inspected each aircraft for airworthiness. Only a few deficiencies were noted and were corrected without delay.

Calibration of spray systems was also done after the mechanical inspection. This was accomplished by loading 15 to 20 gallons of fuel oil into the spray tanks and flying at least two simulated spray runs over cards laid out on the airport runway. White Kromekote cards were placed 5 feet apart for about 200 feet at right angles to the direction of flight. Sudan Black BR dye was added to the fuel oil to facilitate evaluation of spray deposits. In accordance with the contract, all spray aircraft were capable of applying an effective 80-foot swath width.

The preliminary target date to commence spraying was set at May 20, 1965. However, due to unseasonably cold weather and an apparently optimistic starting date, it was necessary to delay the Project several times.

Spraying finally began on a limited scale on June 10 on the Vance Creek Unit. One helicopter sprayed the entire unit of 661 acres on that date.

Evening briefing sessions were held daily at Project Headquarters to plan the next day's operation. A daily record of progress was maintained on large-scale aerial mosaics.

Except for one test load on June 12 spraying did not commence again until June 13. Rain and lack of egg hatch prevented spraying on June 14 and 16. Full-scale operations finally began on June 17 and were fairly continuous until completion of spraying on July 1. Production was limited on June 24 by wind and rain and on June 26 heavy rain prevented any spraying.

Periods of heavy rain and strong winds were encountered at various times throughout the entire Project, thus decreasing time available for optimum flying conditions. However, on several occasions, weather conditions were ideal and spraying was continued until after 3:00 p.m.

Portable radios provided continuous communication link between heliports, lookouts, observation aircraft and spray aircraft.

Heliport managers periodically checked wind velocities at each heliport. Spray operations were normally suspended when wind velocities exceeded 6 m.p.h.

The effects of weather were twofold. Adverse weather not only prevented actual effective spraying but delayed insect hatch. At no time was egg hatch sufficiently advanced to allow release of spray blocks more than one day in advance of spraying.

A gross total of 67,305 acres was sprayed with 67,022 gallons of insecticide solution. Included in this total are 1,360 acres which were resprayed on the King Mountain unit. Respraying of 300 acres was done at the contractor's expense due to inadequate spray coverage. Because of a drenching rainstorm that occurred soon after the first application, respraying of 1,060 acres was done at Government expense.

Because of moderate topography and numerous existing openings in the forest canopy, actual construction of heliports was not necessary. Approximately 20 heliports, located on rock outcrops, meadows, ridgetops, sagebrush flats, and roadways were utilized. Generally, two or three helicopters used each heliport simultaneously. The maximum ferry distance from any heliport was about 2-1/2 miles.

Regional Forester Stone reviews progress of spraying with Project Director Perkins and Air Operations Officer Wear.

SPRAY DISTRIBUTION

To determine the intensity and dispersion of spray reaching the forest floor and to check spray drift, more than 830 oil-sensitive spray deposit cards were distributed throughout the spray areas. The oil-sensitive spray cards were serially numbered and stapled to an 8- by 10-inch cardboard to speed up field distribution and prevent the cards from curling. The cards were placed about one chain apart in the block the day before the area was sprayed. If it rained after the cards had been deposited, they were replaced.

After spraying, the spray cards were collected and brought back to the office for evaluation by comparing them with a set of standards (Davis 1954). The average estimated deposit on the 830 spray cards was 0.36 gallon per acre.

Some cards were not placed in large enough openings in the stand and the heavy canopy prevented most of the spray from reaching the forest floor, thus lowering the estimated spray deposit values. Besides poor location, some spray cards were not anchored and were blown away and a few cards were damaged by animals.

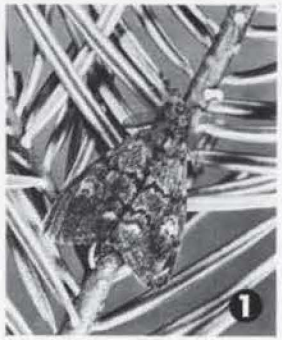
MORTALITY

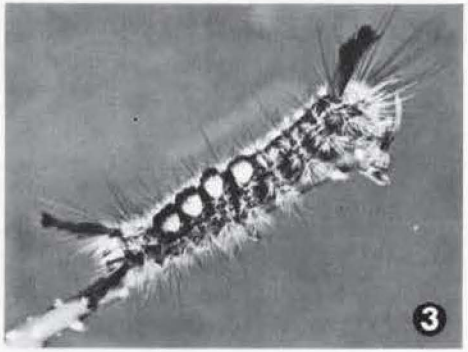
Insect mortality was determined by sampling two different stages of the tussock moth life cycle. One method was a comparison of the pre- and post-spray larval counts, and a second method compared the number of 1964 new egg masses to the number of new egg masses collected in the fall of 1965. The pre- and post-spray larval counts determine mortality almost immediately. The egg mass sample is also desirable because it further substantiates the success of the control project (Evenden and Jost 1947).

A total of 73 pre- and post-spray larval sampling plots was established within the Project area. These plots were located at the observation points and other accessible areas where tussock moth larvae were abundant. The original plan was to establish one mortality plot in each spray block. However, some blocks were either totally or partially inaccessible or could not be sampled in the allotted time.

Originally, plans were made to count 100 tussock moth larvae and place them in a 2-square-foot tray, using tangle-foot around the top of the tray to prevent the larvae from crawling out. This procedure was changed when field observations showed that most of the larvae died before the tray was sprayed. The pre-spray method was changed to clipping two 24-inch branches from each of the five trees on the mortality plot the day before the plot was sprayed. All tussock moth larvae were counted and recorded. These same five trees were visited 10 days after spraying and another 10 branches were clipped and all live larvae were counted for the post-spray population. The difference between the pre- and post-spray counts was presumed to be caused by the insecticide applied and was recorded as percent mortality.

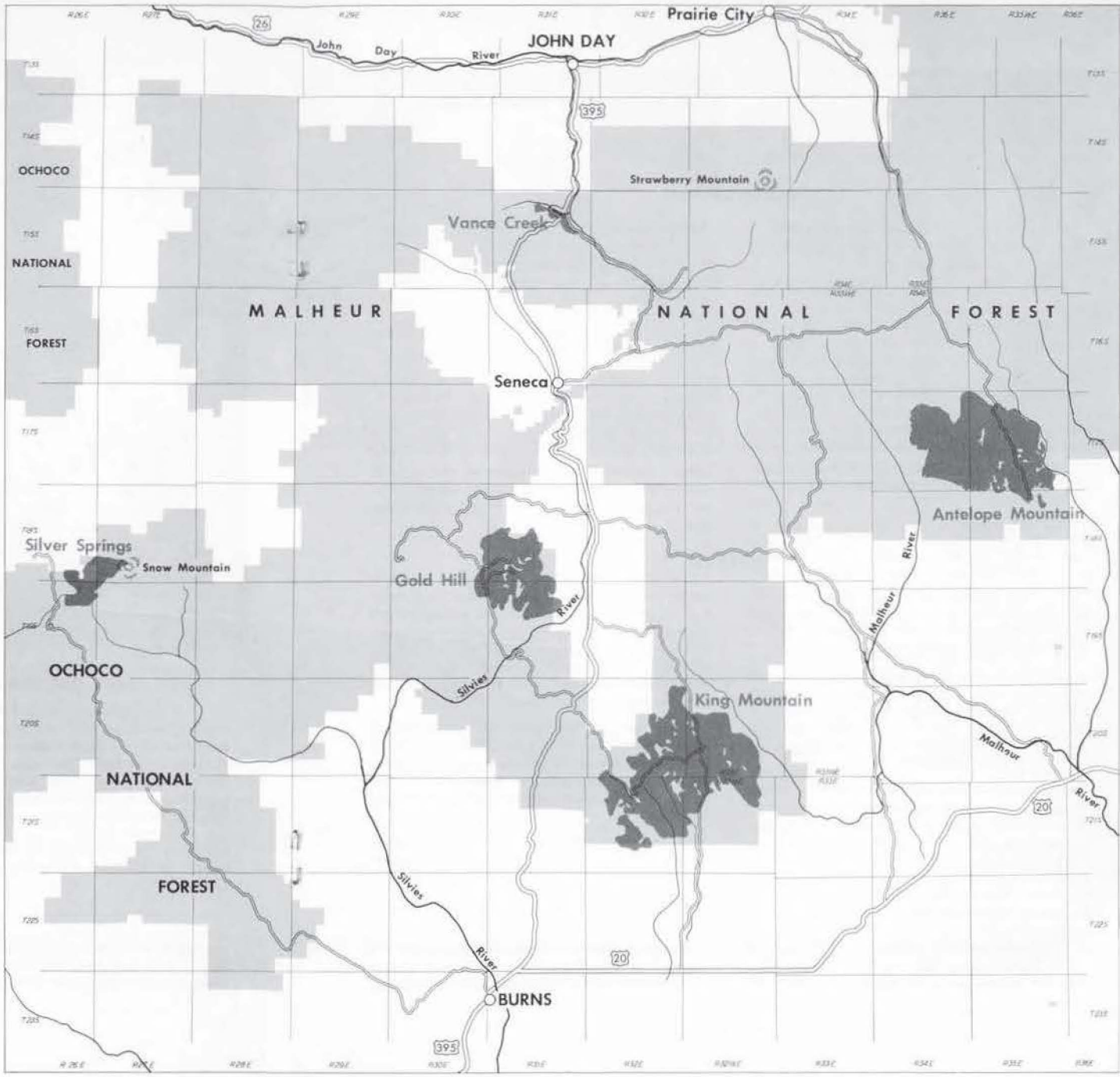
The average mortality for the control project was 98 percent and ranged from 82 to 100 percent (Appendix). The low of 82 percent occurred on Block C, Antelope Mountain. This area was not resprayed because field examinations revealed killing to be higher than the mortality information indicated. This was substantiated during the 1965





Life Cycle of a Forest Killer

The winged male (1) and the wingless female tussock moths mate in the summer. A single female tussock moth may lay as many as 250 eggs on the cocoon from which she emerged (2). The eggs go through the winter and hatch the following spring. Newly hatched caterpillars are hairy, buoyant, and easily blown great distances by the wind. The full grown caterpillar (3) is the most destructive stage of the tussock moth. It can strip the foliage from true firs and Douglas-fir, killing the top or entire tree in one or two seasons. The insect is most vulnerable to control by aerial spraying during the free-feeding caterpillar stage.



Map of Burns Project showing the five spray areas.

egg mass survey in the same area when no new egg masses were found, indicating complete control.

Since the larval method revealed a high mortality rate for the Project, the egg mass survey was used only in the King Mountain and Antelope Mountain units. These two units had the highest population and the lowest virus incidence on the Project before control. The results obtained during the 1964 biological evaluation survey were used for the pre-survey egg mass count. The post-spray egg mass count was made in the fall of 1965.

COOPERATION

In addition to the agencies who cooperated in the surveillance program, three public agencies participated in the operational phases.

The Weather Bureau, U. S. Department of Commerce, assigned a meteorologist to the Project. He was equipped with a mobile weather station and was able to move about throughout the Project area and provide local forecasts. In addition to his own observations and regional forecasts, he was provided weather information from local lookouts and observations from operating heliports. At least two forecasts were provided daily — one immediately before spraying began each morning and one in the late afternoon. These forecasts were exceedingly accurate and proved valuable for planning the next day's operation.

Full cooperation of the Yakima Laboratory of the Agricultural Research Service was given in providing guidance in the collection of samples taken by the several surveillance cooperators and in analyzing those samples. In addition, Agricultural Research Service tested insecticide solutions furnished by the contractor. This included initial testing of ingredients for compatibility with DDT and testing of each final formulation for DDT content.

Upon recommendation of the State Forester, the Oregon State Board of Forestry at its January 6, 1965 meeting passed a resolution establishing a zone of infestation for the Burns Project in accordance with ORS 527.340. The Department of Forestry then began notification, by written notice and personal contact, of the private owners of timberlands within the infestation zone to advise them of the needs and plans for control.

RESULTS

The Burns Project was considered highly successful with virtually complete mortality of the target insect. The Project was completed without complaint from any group or individual.

Contractors complied with the terms of contracts exceedingly well. Only a few minor operational problems developed during the Project and were quickly corrected. One helicopter spray day was lost due to a malfunctioning supercharger on one of the Bell spray helicopters.

An accidental loss of insecticide occurred in the Silvies Valley on the evening of June 23, 1965. A seam on the underside of a tanker ruptured and approximately 800 gallons of formulated insecticide solution was spilled. The loss occurred as the tank truck was traveling along a gravel road skirting the Silvies Valley. The spill occurred directly on the gravel road with some insecticide solution flowing across the road and into a bare cattle feedlot. All of the solution was absorbed into the ground before it had gone 100 feet across the feedlot. However, a heavy rain occurred shortly after the accident and apparently washed some of the solution through the feedlot and across a meadow into an irrigation ditch about 100 feet beyond the feedlot. It is assumed that only a minor quantity of insecticide solution actually entered the ditch. The irrigation ditch empties into the Silvies River approximately one mile below the spill area.

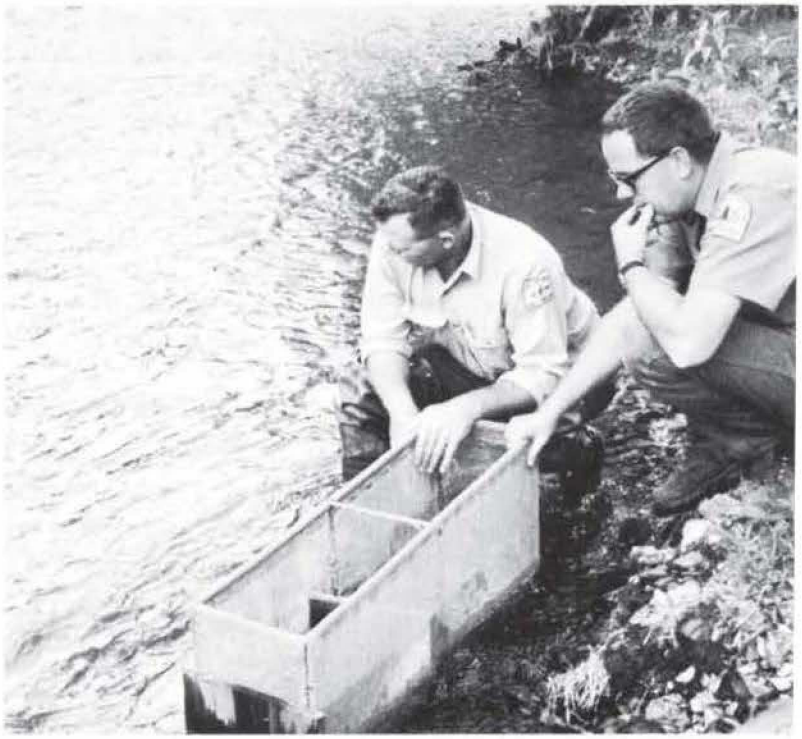
Early on June 24, Forest Service and Bureau of Sport Fisheries and Wildlife personnel made extensive observations and collected water and aquatic insect samples in the spill area and the Silvies River. Results of the observations which continued for several days were:

1. Heavy aquatic insect and mosquito mortality occurred in the irrigation ditch but only in the immediate vicinity of the spill area.

2. No fish kill was observed in either the ditch or Silvies River.

3. Daily helicopter flights were made over the Silvies River from Burns to the spill area, but no oil slicks or evidence of pollution were observed.

Game Commission personnel collected water and fish samples before and after spraying from key fish-bearing streams.



Boxes containing live trout were placed in streams to determine the effect, if any, from adjacent spray areas.

Analysis of a water sample taken on June 24 from the ditch at the spill area showed a DDT residue level of 22.5 ppb, but samples taken from the Silvies River above and below the ditch confluence showed no traces of DDT.

Safety was apparently paramount to all personnel. Only one minor motor vehicle accident occurred. A rear-door window of a panel was broken by an improperly secured oil drum.

Two minor accidents occurred during the entire Project — one a bruised elbow and one a cut finger. An employee bumped his elbow on a vehicle gearshift level and another employee cut his finger while opening a can of beans for lunch. Neither injury required a doctor's attention.

Except as noted above, there were no reportable motor vehicle accidents. This record includes both Government and contractor equipment and personnel.

The cost of the Burns Project was shared by the Governmental agencies and the private landowners. This is in accordance with a Cooperative Agreement between the office of the State Forester, Oregon State Board of Forestry, and the Forest Service, U. S. Department of Agriculture, for control of destructive forest insects and diseases. The authority for sharing is provided in Federal and State Pest Control Acts. Accordingly, the Federal Government paid the entire cost for Federal lands and 25 percent of the costs for private lands. The State of Oregon paid the entire cost for State lands and 37-1/2 percent of the cost on private lands. Private owners paid the remaining 37-1/2 percent of the cost on their lands.

The total cost to the State and private landowners, which included only these costs eligible for cost-sharing under the Cooperative Agreement between the Board of Forestry and the Forest Service, was $217,210.79 or $3.29 per acre. This total does not include costs for surveillance, public relations, salaries and expenses of permanent insect and disease control personnel, or non-expendable property items.

Total expenditures for the entire Project were $243,237.58 or $3.69 per acre. A detailed summary of costs is shown in the Appendix.

Surveillance work is still underway and will not be completed for some time. Results of that work will, for the most part, be published later by the individual cooperator. However, preliminary results show that no apparent damage to any resource has

occurred. To date, some samples analyzed indicated apparent DDT residue. However, residue levels were below that found normally in any apparently uncontaminated water supply or below established tolerances.

Newspaper and television coverage of the Project throughout the Northwest was excellent. Two full-page feature articles were published in the Portland Oregonian while the Project was underway. A feature article was published in the March 1966 issue of American Forests magazine. In addition, a 12-1/2-minute color movie of the Burns Project, "Operation Spray Safe," has been prepared by the Department's Motion Picture Service.

Precision spraying as accomplished on the the Burns Project indicates that effective forest aerial spraying can be accomplished without apparent pollution or damage.

RECOMMENDATIONS

The many previous recommendations made after aerial spray projects throughout the Nation were carefully reviewed during the planning stages of the Project. Many seemed to be worthwhile and, where possible, were incorporated into the Project plans and/or contracts. Thus, apparently many of the pitfalls encountered previously were avoided.

However, the following recommendations are mentioned or reemphasized for consideration in future projects.

1. No more radios should be installed in spray aircraft than are absolutely necessary. Too many frequencies result in spray pilots receiving orders from too many bosses and confusion.

2. If several vehicles are to be moved some distance, possible cheaper transportation by convoy carrier should be considered.

3. Extreme care should be taken in the determination of when aircraft are called to duty. Premature ordering before the actual needed date and subsequent waiting on previous projects has later resulted in almost exorbitant bid rates in some cases.

4. Key personnel should be designated and detailed, even if only part time, early in the planning stages in order to become familiar with the project. This is particularly desirable for the administrative officer.

5. Consideration should be given to development of a regional or inter-regional overhead team for effective and economical administration of control projects. Organization of a team might be patterned after regional fire overhead teams and, of course, the benefits of such are obvious.

6. The guidelines mentioned in the "Temperature and Egg Hatch" section (Appendix) would be helpful in determining time of egg hatch and spraying on Douglas-fir tussock moth projects.

BIBLIOGRAPHY

Davis, J. M.
1954. Standards for Estimating Airplane Spray Deposits on Oil-Sensitive Cards. U. S. Dept. Agr., Forest Serv. Unnumbered Booklet.

Evenden, James C. and Jost, E. J.
1947. Tussock Moth Control, North Idaho, 1947. U. S. Forest Serv., Northern Region, 27 pp. and appendix, illus.

McComb, David
1965. Entomological Evaluation of the Douglas-fir Tussock Moth in Eastern Oregon, 1964. U. S. Forest Serv., Pacific N. W. Region 5250 Rpt., 12 pp.

———
1966. Dursban and Zectran Pilot Control Study for Douglas-fir Tussock Moth. U. S. Forest Serv., Pacific N. W. Region 5200 Rpt., 7 pp.

Perkins, Randall F., Wear, John F., Dolph, Robert E., and others
1965. Project Plans for the 1965 Burns Tussock Moth Control Project. U. S. Forest Serv., Pacific N. W. Region 5250 Rpt., 50 pp. and map.

APPENDIX

	Page
Statistical Summary	18
Agencies and Others Invited to Participate	19
Organization Chart	20
List of Federal Personnel	21
List of Contracting Personnel	23
Bid Summary	23
Dates Spray Blocks Released and Sprayed and Estimated Spray Deposit (Table 1)	24
Summary of Tussock Moth Larval Mortality (Table 2)	24
Mortality of Egg Masses (Table 3)	25
Daily Production by Spray Unit (Table 4)	25
Observer Helicopter Time (Table 5)	26
Project Cost Summary (Table 6)	26
Temperature and Egg Hatch	26
Location of Weather Stations (Table 7)	27
Cumulative Temperature (Table 8)	27
Daily Average Cumulative Temperature (Figure 1)	28
Map	12

STATISTICAL SUMMARY

Acreage	
Private	1,887
State	380
National Forest	63,678
Total net acres sprayed	65,945
Acres resprayed	1,360
Total gross acres sprayed	67,305
Cost per net acre	
Insecticide	$0.58
Application	$1.87
Observation	$0.21
Administration, etc.	$1.03
Total cost per acre	$3.69
Total cost of project	$243,237.58
Man-hours worked	
Forest Service (32 employees)	11,000
Contracting personnel (20+)	5,000
Total man-hours	16,000
Gallons of insecticide solution used (3/4-pound DDT in one gallon fuel oil)	67,022
Aircraft hours	
Application helicopters (4-Hiller 12E, 2-Bell G3B)	229:25
Observation helicopters (1-Bell G3B, 1-Bell G3B-1)	134:47
Forest Service helicopter (Hiller 12E4)	85:15
Forest Service Cessna 180	39:15
Forest Service other	19:40
Total hours	508:22
Aircraft production	
Application helicopters:	
Helicopter days	74
Average hours/flight day	3:06
Acres/hour	293
Acres/flight day	910
Observation helicopters:	
Helicopter days	31
Average hours/flight day	4:21

AGENCIES AND OTHERS INVITED TO PARTICIPATE IN OR COMMENT ON THE PROPOSED BURNS PROJECT

Federal

Agricultural Research Service
Bureau of Commercial Fisheries
Bureau of Land Management
Bureau of Sport Fisheries and Wildlife
Federal Aviation Agency
Geological Survey
Pacific Northwest Forest and Range Experiment Station
Public Health Service
Weather Bureau

State af Oregon

Board of Health
Department of Agriculture
Department of Forestry
Fish Commission
Game Commission
Oregon State University
Sanitary Authority

State of Washington

Department of Natural Resources

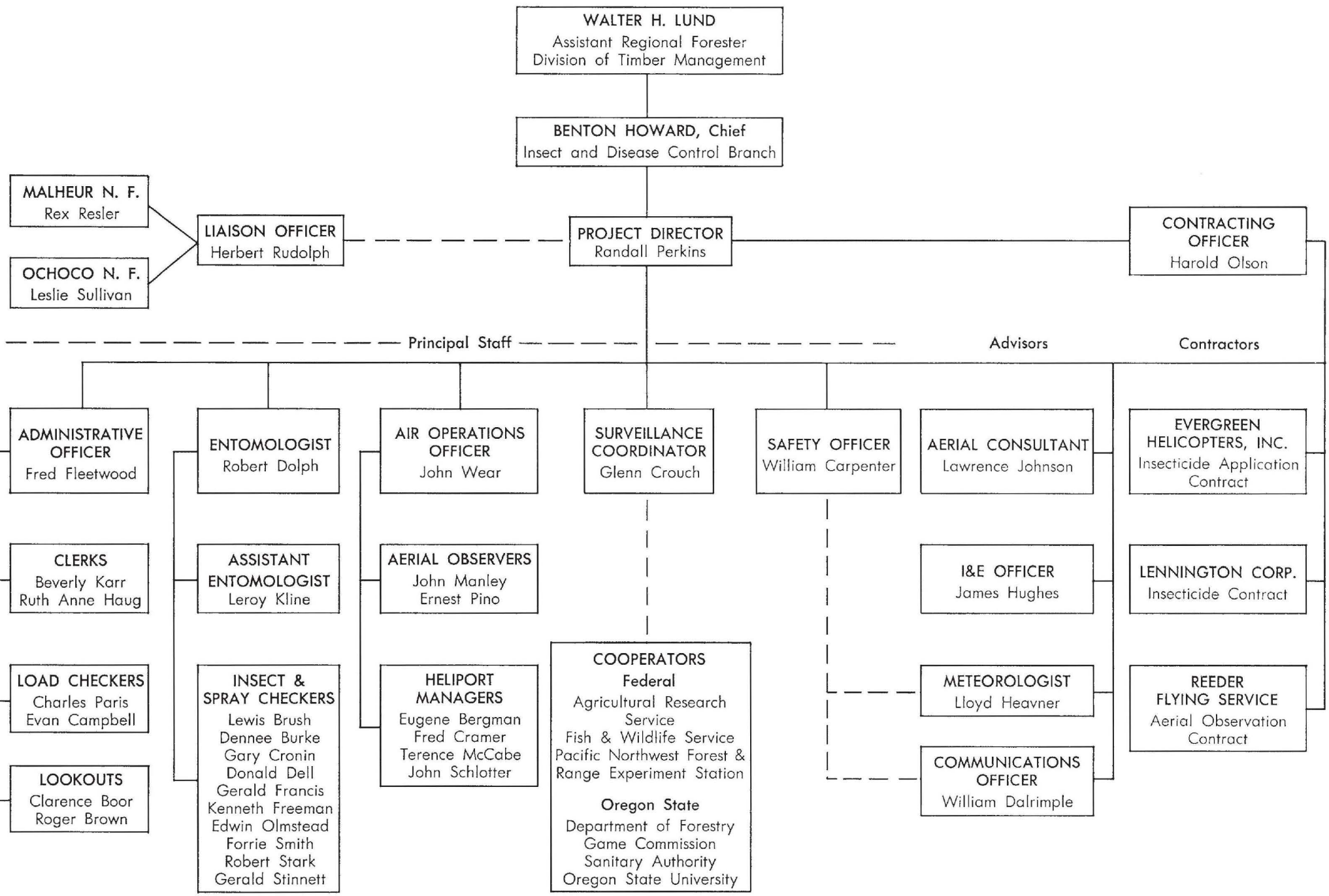
Industry

American Forest Products Association
Edward Hines Lumber Company
Industrial Forestry Association
Western Forestry and Conservation Association
Western Wood Products Association
Weyerhaeuser Company

Others

Burns Chamber of Commerce
Harney County Court
Izaak Walton League
Malheur National Forest Advisory Council
Malheur National Forest Grazing Advisory Board
National Forest Grazing Permittees
Northwest Forest Pest Action Council
Oregon Audubon Society
Oregon Cattlemen's Association
Oregon Wildlife Federation
Pacific Northwest Regional Advisory Council
Private Landowners
Wildlife Management Institute

ORGANIZATION — BURNS PROJECT



LIST OF FEDERAL PERSONNEL

Name	Project title	Duties	Provided by
Randall F. Perkins	Project Director	Planned and supervised entire project. (Spray, insecticide and observation contracts C. O. R.)	Regional Office, Timber Management
Herbert B. Rudolph	Liaison Officer	Coordinator for Malheur and Ochoco National Forests.	Malheur National Forest
Harold E. Olson	Contracting Officer	Contracting officer for insecticide, application, and observation contracts.	Regional Office, Operation
John F. Wear	Air Operations Officer and Assistant Project Director	Planned and supervised all flight and spray operations.	Regional Office, Timber Management
Robert E. Dolph	Project Entomologist	Planned and supervised all entomological phases of project.	Deschutes National Forest
Frederic L. Fleetwood	Administrative Officer	Supervised business management phase.	Umatilla National Forest
William V. Carpenter	Safety Officer	Planned and supervised weather observing, transportation, and safety phases of project.	Okanogan National Forest
Glenn L. Crouch	Surveillance Coordinator	Coordinator for all surveillance activities.	Mt. Hood National Forest
Lawrence H. A. Johnson	Aerial Consultant	Advisor to Director and Air Operations Officer on all aerial phases.	Regional Office, Fire Control
James W. Hughes	Information and Education Officer	Advisor to Director on public relations problems. Liaison for news media.	Regional Office, Information and Education
Lloyd C. Heavner	Meteorologist	Provided daily weather forecasts and prediction of spraying opportunity.	Weather Bureau, Pendleton
Leroy N. Kline	Assistant Entomologist	Chief assistant to Project Entomologist.	Malheur National Forest
Ernest J. Pino	Aerial Observer	Continuous monitoring of spray operation.	Okanogan National Forest
John Manley	- Do -	- Do -	Siskiyou National Forest
Terence L. McCabe	- Do -	- Do -	Okanogan National Forest

LIST OF FEDERAL PERSONNEL—Continued

Name	Project title	Duties	Provided by
Eugene H. Bergman	Heliport Manager	Supervised entire operation of 1 to 3 helicopters at assigned heliport.	Rogue River National Forest
Fred Cramer	- Do -	- Do -	Siskiyou National Forest
John P. Schlotter	- Do -	- Do -	- Do -
William Dalrimple	Communications Officer	Installed and maintained radio network.	Malheur National Forest
Lewis Brush	Insect Checker	Established observation plots and determined egg hatch. Distributed spray cards. Made pre- and post-spray larval counts on mortality plots.	- Do -
Dennee Burke	- Do -	- Do -	- Do -
Gary Cronin	- Do -	- Do -	Ochoco National Forest
Donald Dell	- Do -	- Do -	Malheur National Forest
Gerald Francis	- Do -	- Do -	Ochoco National Forest
Kenneth Freeman	- Do -	- Do -	Malheur National Forest
Edwin Olmstead	- Do -	- Do -	- Do -
Forrie Smith	- Do -	- Do -	- Do -
Robert Stark	- Do -	- Do -	- Do -
Gerald Stinnett	- Do -	- Do -	- Do -
Charles Paris	Load Checker	Supervised loading at insecticide storage facilities.	- Do -
Evan Campbell	- Do -	- Do -	- Do -
Beverly Karr	Clerk	General clerical duties.	- Do -
Ruth Ann Haugh	- Do -	General clerical duties and radio operator.	- Do -
Clarence Boor	Antelope Mountain Lookout	Made weather observations. Relayed radio messages.	- Do -
Roger Brown	King Mountain Lookout	- Do -	- Do -

LIST OF CONTRACTING PERSONNEL

Aerial Spray Contract — Evergreen Helicopters

Delford M. Smith	Contractor and Chief Pilot
Elton Eby	Pilot
Allen Cole	Pilot
Dale Hill	Pilot
John Wolhaupter (Hillcrest Aviation)	Pilot
George Carlson (Reforestation Services)	Pilot
Jack Devore (Reforestation Services)	Pilot
William Murray (Grote Aviation)	Pilot
Norman McGrew	Mechanic
Lynn Ankrum	Mechanic
William Jones (Reforestation Services)	Mechanic and loader
Robert Wasson	Loader
Lloyd Roberts	Loader
Jack Bechtel	Loader
Paul Blair (Hillcrest Aviation)	Loader
Donald Parks (Grote Aviation)	Loader

Observation Contract — Reeder Flying Service

Donald Griffis	Pilot
Wayne Rowe (Farnsworth Aviation)	Pilot

Insecticide Contract — The Lennington Corp.

W. M. Lennington	Contractor
James Trexler	Truck driver and loader
Thomas Jeppeson	Truck driver and loader
William Shefcheck	Truck driver and loader

BID SUMMARY

Insecticide Contract

Approximately 55,600 gallons of formulated DDT insecticide delivered to storage facilities at Burns and Summit Prairie, Oregon.

Bidder	Address	Unit bid rate	Total
The Lennington Corporation	Vancouver, Wash.	$0.58/gal.	$32,248.00 *
Stauffer Chemical Company	Portland, Oregon	0.615/gal.	34,194.00

Observation Contract

Provide two helicopters. Approximately 100 hours aerial reconnaissance. Seventy hours guaranteed.

Bidder	Address	Unit bid rate	Total
Reeder Flying Service	Twin Falls, Idaho	$104.00/hr.	$10,400.00 *
Meade Helicopters	Porterville, Calif.	111.60/hr.	11,600.00
Helicopter Services	Yakima, Washington	117.00/hr.	11,700.00
Farnsworth Aviation	Boise, Idaho	119.95/hr.	11,995.00
Etna Helicopters, Inc.	Etna, California	129.50/hr.	12.950.00
Whirl-Wide Helicopters	Fresno, California	147.20/hr.	14,720.00

Aerial Spraying Contract

Provide at least six helicopters equipped for aerial spraying.

Bidder	Address	Unit bid rate	Total
Evergreen Helicopters	McMinnville, Oregon	$1.85/ac.	$102,860.00 *

* Accepted bid.

Table 1.—Dates individual spray blocks were released and sprayed and estimated spray deposit on oil-sensitive dye cards

Spray area						
Unit	Block	Size (acres)	Date released	Date sprayed	Number of spray cards	Average estimated gal./acre
King Mountain	B	1,226	6-23	6-25	9	0.6
	C	1,693	6-20	6-21	10	0.7
	D	1,410	6-28	6-29	10	0.5
	E	1,238	6-20	6-21	20	0.5
	EJ	823	6-17	6-18	18	0.3
	F	2,712	6-15	6-18	28	0.2
	G	2,795	6-28	6-29	25	0.3
	H	1,942	6-22	6-27	30	0.3
	I	1,924	6-21	6-23	20	0.3
	J	2,773	6-21	6-23	35	0.4
	K	1,789	6-16	6-18	20	0.3
	L	3,886	6-18	6-20	30	0.3
	M	2,878	6-21	6-23	20	0.5
	N	1,605	6-13	6-17	158	0.2
Unit total	14	28,694*	--	--	433	0.4
Antelope Mountain	AB	3,700	6-21	6-24	48	0.5
	C	1,120	6-11	6-13	20	0.3
	C-1	1,874	6-15	6-19	30	0.2
	D	1,535	6-12	6-15	20	0.2
	E	4,105	6-18	6-20	49	0.3
	F	3,729	6-13	6-19	30	0.2
	F-1	3,181	6-23	6-27	32	0.3
	F-2	681	6-15	6-19	10	0.3
	G	3,075	6-20	6-24	28	0.4
Unit total	9	23,000	--	--	267	0.3
Gold Hill	A	2,025	6-27	6-28	0	0.0
	B	5,040	6-23	6-25	43	0.6
	C	1,660	6-27	6-28	26	0.3
	D	1,605	6-27	6-28	0	0.0
	E	1,325	6-28	6-29	9	0.3
Unit total	5	11,655	--	--	78	0.4
Vance Creek	A	661	--	6-10	24	0.3
Unit total	1	661	--	--	24	0.3
Silver Springs	A	3,295	6-29	6-30	28	0.3
Unit total	1	3,295	6-9	--	28	0.3
Total	30	67,305*	--	--	830	0.36

*Includes 1,360 acres resprayed.

Table 2.—Summary of tussock moth larval mortality on the 1965 Burns Douglas-fir tussock moth control project

Unit	Spray block	Number of mortality plots	Larval count		Percent mortality [1]
			Pre-spray	Post-spray	
King Mountain	B	3	260	0	100
	C	2	448	1	99
	D	2	90	0	100
	E	3	494	7	99
	EJ	1	81	7	91
	F	5	455	1	99
	G	10	822	2	99
	H	0	0	0	0
	I	1	100	6	94
	J	5	728	10	99
	K	2	276	0	100
	L	6	292	21	93
	M	1	86	1	99
	N	1	247	14	94
Unit total	14	42	4,379	70	98
Antelope Mountain	AB	2	50	0	100
	C	2	397	72	82
	C-1	1	165	0	100
	D	0	0	0	0
	E	2	615	0	100
	F	2	238	2	99
	F-1	4	318	0	100
	F-2	1	41	3	93
	G	1	30	0	100
Unit total	9	15	1,854	77	96
Gold Hill	A	0	0	0	0
	B	5	449	0	100
	C	2	283	0	100
	D	0	0	0	0
	E	1	145	0	100
Unit total	5	8	877	0	100
Vance Creek	A	2	200	0	100
Unit total	1	2	200	0	100
Silver Springs	A	3	182	0	100
Unit total	1	3	182	0	100
Project total	30	70	7,492	147	Ave. 98

Table 3.—Mortality of fall-1965 tussock moth egg masses in relation to fall-1964 egg masses

Control unit	1964		1965		Percent mortality
	Number plots	Pre-spray cocoon count	Number plots	Post-spray cocoon count	
King Mountain	1	84	1	0	100
	2	95	2	0	100
	3	114	3	0	100
	4	114	4	0	100
	5	83	5	0	100
	6	84	6	0	100
	7	80	--	*	--
	8	108	--	*	--
	9	95	--	*	--
	10	92	--	*	--
	11	82	--	*	--
	12	83	--	*	--
Unit total	--	1,114	--	0	100
Antelope Mountain	1	109	1	0	100
	2	119	2	0	100
	3	40	3	0	100
	4	67	4	0	100
	5	87	5	0	100
	6	60	6	0	100
	7	77	--	*	--
	8	110	--	*	--
	9	119	--	*	--
	10	87	--	*	--
	11	104	--	*	--
Unit total	--	979	--	0	100
Project total	23	2,093	12	0	100

* Not sampled in 1965.

Table 4.—Daily production by spray unit

Date	Antelope Mountain			Gold Hill			King Mountain			Silver Springs			Vance Creek			Daily total		Cumulative total	
	Acres	Number of aircraft	Hours and minutes	Acres	Number of aircraft	Hours and minutes	Acres	Number of aircraft	Hours and minutes	Acres	Number of aircraft	Hours and minutes	Acres	Number of aircraft	Hours and minutes	Acres	Hours and minutes	Acres	Hours and minutes
6/10	--	--	--	--	--	--	--	--	--	--	--	--	661	1	2:30	661	2:30	661	2:30
6/11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/12	70	1	0:30	--	--	--	--	--	--	--	--	--	--	--	--	70	0:30	731	3:00
6/13	2,090	3	8:06	--	--	--	--	--	--	--	--	--	--	--	--	2,090	8:06	2,821	11:06
6/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/15	3,699	3	13:46	--	--	--	--	--	--	--	--	--	--	--	--	3,699	13:46	6,520	24:52
6/16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/17	750	3	3:11	--	--	--	3,395	2	12:16	--	--	--	--	--	--	4,145	15:27	10,665	40:19
6/18	1,001	3	3:43	--	--	--	3,054	2	9:25	--	--	--	--	--	--	4,055	13:08	14,720	53:27
6/19	3,248	4[1]	13:03	--	--	--	3,359	3[1]	11:34	--	--	--	--	--	--	6,607	24:37	21,327	78:04
6/20	1,546	3	5:42	--	--	--	427	1	1:27	--	--	--	--	--	--	1,973	7:09	23,300	85:13
6/21	1,611	2	5:23	--	--	--	2,812	3	9:09	--	--	--	--	--	--	4,423	14:32	27,723	99:45
6/22	2,460	3	8:11	--	--	--	3,450	3	11:10	--	--	--	--	--	--	5,910	19:21	33,633	119:06
6/23	3,380	3	11:07	--	--	--	3,607	3	11:40	--	--	--	--	--	--	6,987	22:47	40,620	141:53
6/24	561	2	1:38	--	--	--	--	--	--	--	--	--	--	--	--	561	1:38	41,131	143:31
6/25	1,332	2	4:28	3,931	3	12:07	1,406	1	4:34	--	--	--	--	--	--	6,669	21:09	47,850	164:40
6/26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6/27	1,252	2	4:29	1,897	2	6:37	1,554	2	5:40	--	--	--	--	--	--	4,703	16:46	52,553	181:26
6/28	--	--	--	4,502	6	15:09	--	--	--	--	--	--	--	--	--	4,502	15:09	57,055	196:35
6/29	--	--	--	1,325	1	4:13	3,700	3	11:41	--	--	--	--	--	--	5,025	15:54	62,080	212:29
6/30	--	--	--	--	--	--	1,070[2]	1	4:35	3,295	3	10:36	--	--	--	4,365[2]	15:11	66,445	227:40
7/1	--	--	--	--	--	--	860[3]	1	1:45	--	--	--	--	--	--	860[3]	1:45	67,305	229:25
Total	23,000	--	83:17	11,655	--	38:06	28,694	--	94:56	3,295		10:36	661		2:30	67,305	229:25	67,305	229:25
																-1,360	(Respray)		
																Total net acres sprayed	65,945		

[1] One helicopter sprayed on both units.

[2] Includes 500 acres respray.

[3] Respray.

Table 5.—Observer helicopter time (contract ships only)

Helicopter No. N73978					Helicopter No. N73248				
Date	Hours	Minutes	Cumulative total		Date	Hours	Minutes	Cumulative total	
			Hours	Minutes				Hours	Minutes
6/9	1	35	1	35	--	--	--	--	--
6/10	4	25	6	0	--	--	--	--	--
6/11	1	12	7	12	--	--	--	--	--
6/12	0	58	8	10	--	--	--	--	--
6/13	4	10	12	20	--	--	--	--	--
6/14	--	--	--	--	--	--	--	--	--
6/15	7	33	19	53	6/15	5	48	5	48
6/16	0	50	20	43	6/16	2	8	7	56
6/17	2	30	23	13	6/17	7	41	15	37
6/18	2	19	25	32	6/18	5	44	21	21
6/19	5	6	30	38	6/19	6	35	27	56
6/20	3	48	34	26	6/20	--	--	--	--
6/21	4	30	38	56	6/21	4	55	32	51
6/22	4	10	43	6	6/22	5	20	38	11
6/23	4	48	47	54	6/23	5	37	43	48
6/24	2	43	50	37	6/24	3	4	46	52
6/25	2	17	52	54	6/25	6	17	53	9
6/26	--	--	--	--	6/26	--	--	--	--
6/27	4	48	57	42	6/27	5	55	59	4
6/28	6	8	63	50	--	--	--	--	--
6/29	6	3	69	53	--	--	--	--	--
6/30	5	50	75	43	--	--	--	--	--

Total observation time: 134 hours, 47 minutes

Table 6.—Project cost summary

	Eligible for cost sharing with State	Surveillance	Information and education, public relations	Expenses of permanent pest control personnel	Total
Salaries and wages	$24,678.53	$2,150.00	--	$11,072.51	$37,901.04
Equipment use	3,027.41	500.00	$150.00	2,074.17	5,751.58
Travel (per diem, etc.)	6,982.01	336.00	--	3,015.23	10,333.24
Rent and utilities	855.16	200.00	50.00	--	1,105.16
Supplies and materials	1,141.59	766.02	604.53	30.69	2,542.83
Nonexpendable property	--	--	--	142.97	142.97
Forest Service aircraft	4,600.00	700.00	1,256.25	2,978.42	9,534.67
Insecticide	38,483.46	--	--	--	38,483.46
Spraying contract	123,495.25	--	--	--	123,495.25
Observation helicopter contract	13,947.38	--	--	--	13,947.38
Total	$217,210.79	$4,652.02	$2,060.78	$19,313.99	$243,237.58
Cost/acre (65,945 net acres)	$3.29	$0.07	$0.03	$0.30	$3.69

TEMPERATURE AND EGG HATCH

The 1965 control Project demonstrated a need for predicting the time of Douglas-fir tussock moth egg hatch. All control actions were governed by the date of egg hatch. The general statement, "sometime after mid-May," was too vague for efficient administration and deployment of men and supplies. Although contracts for material and equipment must be prepared and let far in advance, timing the call for men and planes can be improved to reduce costs.

The most apparent logical approach for predicting egg hatch is to relate hatch with air temperature. This relationship was unknown during the 1965 Project. Only after the Project was completed was there an attempt to determine at what temperature egg hatch had occurred.

A meteorologist was assigned to the Project, but he did not arrive until after the egg hatch had begun. His primary duty was to provide weather data pertaining to the flying and spraying operations.

Since no weather station was located within any one of the control units, a total of four U. S. Weather Stations located near the Project were selected (table 7).* For each of the four weather stations a daily mean temperature was calculated and a cumulative total was determined for the period May 1 to June 30. Once this calculation was made, the egg hatch records were checked for the dates of the first egg hatch on each of the five infestations, and the total number of days since May 1 were counted. Then the cumulative total of degrees was divided by the number of days between May 1 and egg hatch to establish the average daily temperature.

* Climatological Data Monthly Report for Oregon, 71 (5&6). 1965. U. S. Dept. Commerce, Asheville, N. C.

Table 7.—Elevation differences and distances between weather stations and spray units

Weather station	Elevation	Spray unit	Average elevation	Miles from station to unit
	Feet		Feet	
John Day	3,063	Vance Creek	3,900	11
Van	4,095	Antelope Mountain	5,600	14
Burns	4.151	King Mountain	5,800	20
Seneca	4,666	Gold Hill	5,500	11
		Silver Springs	7,000	28

The first egg hatch on the Project was reported on June 3 on the Vance Creek unit. Using John Day weather records, a total of 1,762 degrees had accumulated from a base of 52°F. The daily average cumulative temperature for the 34-day period was 51.8°F (table 8 and figure 1). The next egg hatch occurred on June 7 on the King Mountain and the Antelope Mountain units. Weather data from the Burns Station was used for the King Mountain unit. From a base of 38°F, the cumulative temperature for the 38-day period was 1,973 degrees. The daily average cumulative temperature for this period was 51.9°F.

The Antelope Mountain egg hatch was related to temperatures recorded at Van, Oregon. From a base of 45°F, a total of 1,927 degrees had accumulated for the 38-day period between May 1 and June 7 with an average daily cumulative temperature of 50.7°F.

The first egg hatch on the Gold Hill unit was not reported until June 12. Temperature readings taken at the Seneca Station showed 1,969 degrees had accumulated from a base of 45°F during the 43-day period. The daily average cumulative temperature was 45.8°F.

Tussock moth eggs on the Silver Springs unit did not start to hatch until June 24. Based on the weather data collected at the Seneca Station, a total of 2,664 degrees had accumulated for the 55-day period. The daily average temperature at hatch time was 48.4°F. This was the highest unit on the Project, averaging about 7,000 feet elevation. Cool temperatures persisted at this high elevation due to three inches of hail and snow on the ground which remained for two days after the first hatched egg was observed.

Egg hatch did not occur simultaneously on the five infestation centers nor on an individual center. Changes in elevation and aspect prevented a general overall hatch. No attempt was made to correlate egg hatch with these factors. However, on the average, eight additional days were needed before egg hatch was general enough to release the area for spraying.

Although the reliability of the cumulative temperature gradient method is unknown, it seems that whenever the daily average cumulative air temperature nears 50°F, Douglas-fir tussock moth eggs are likely to start hatching. It is suggested that whenever a Douglas-fir tussock moth outbreak develops again in the Pacific Northwest, this temperature-egg hatch correlation factor be used for deploying control personnel and equipment into the areas where chemical control is planned.

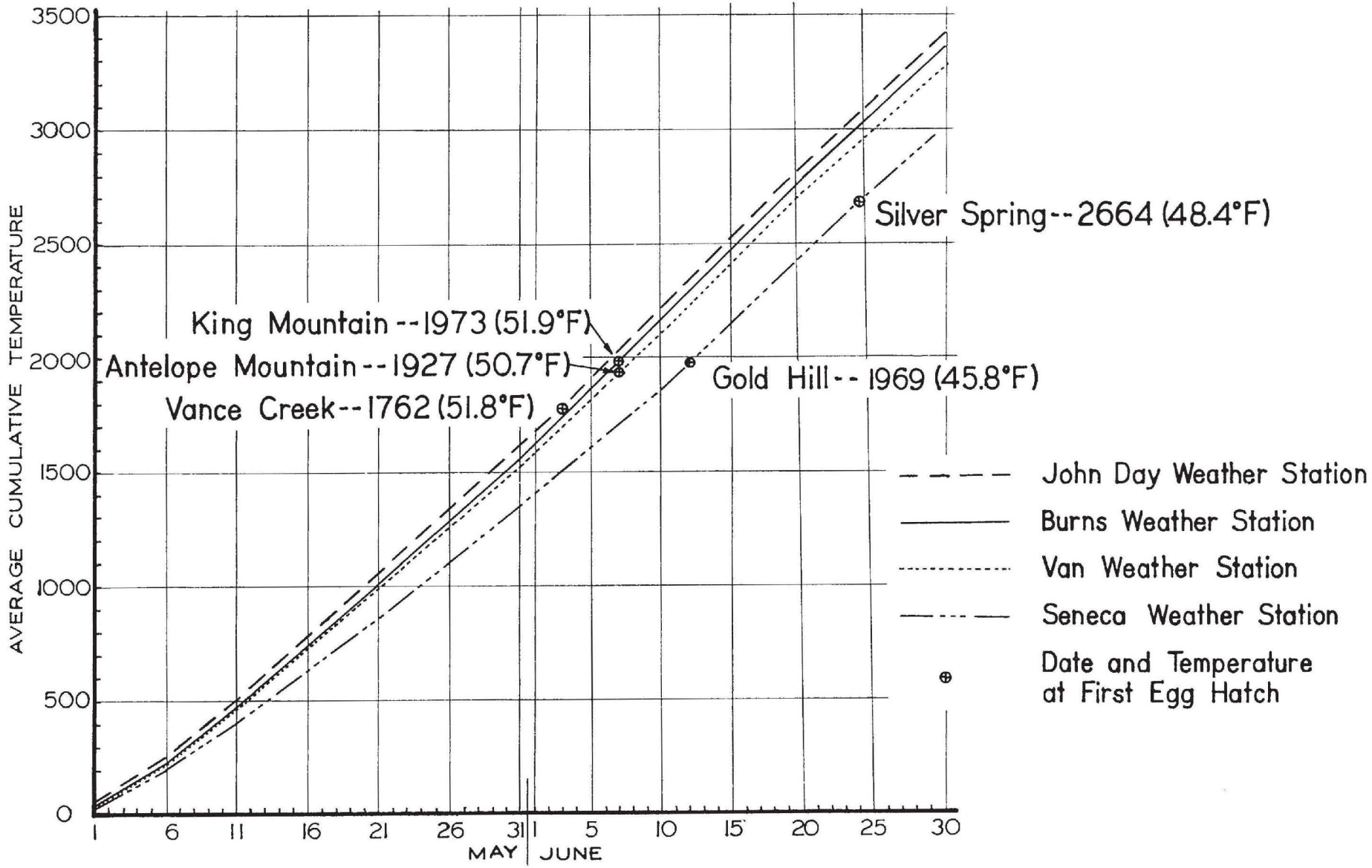
Table 8.—Cumulative temperature from May 1 to egg hatch and cumulative temperature at spray time

Weather station	Spray unit	Date of first egg hatch	Cumulative temperature to hatch	Days May 1 to hatch	Ave. cumul. temperature at hatch	Incubation days to spray	Cumulative temperature to spray	Ave. cumul. temperature at spray
			°F	No.	°F	No.		°F
John Day	Vance Creek	June 3	1,762	34	51.8	6	2,205	53.8
Van	Antelope Mountain	June 7	1,927	38	50.7	5	2,243	52.2
Burns	King Mountain	June 7	1,973	38	51.9	9	2,550	53.1
Seneca	Gold Hill	June 12	1,969*	43	45.8	12	2,664	48.4
	Silver Springs	June 24	2,664*	55	48.4	7	2,975	50.0
		Average	2,059	41.6	49.7	7.8	2,527	51.5

* Estimated, three days records missing from Seneca Weather Station data.

FIGURE 1

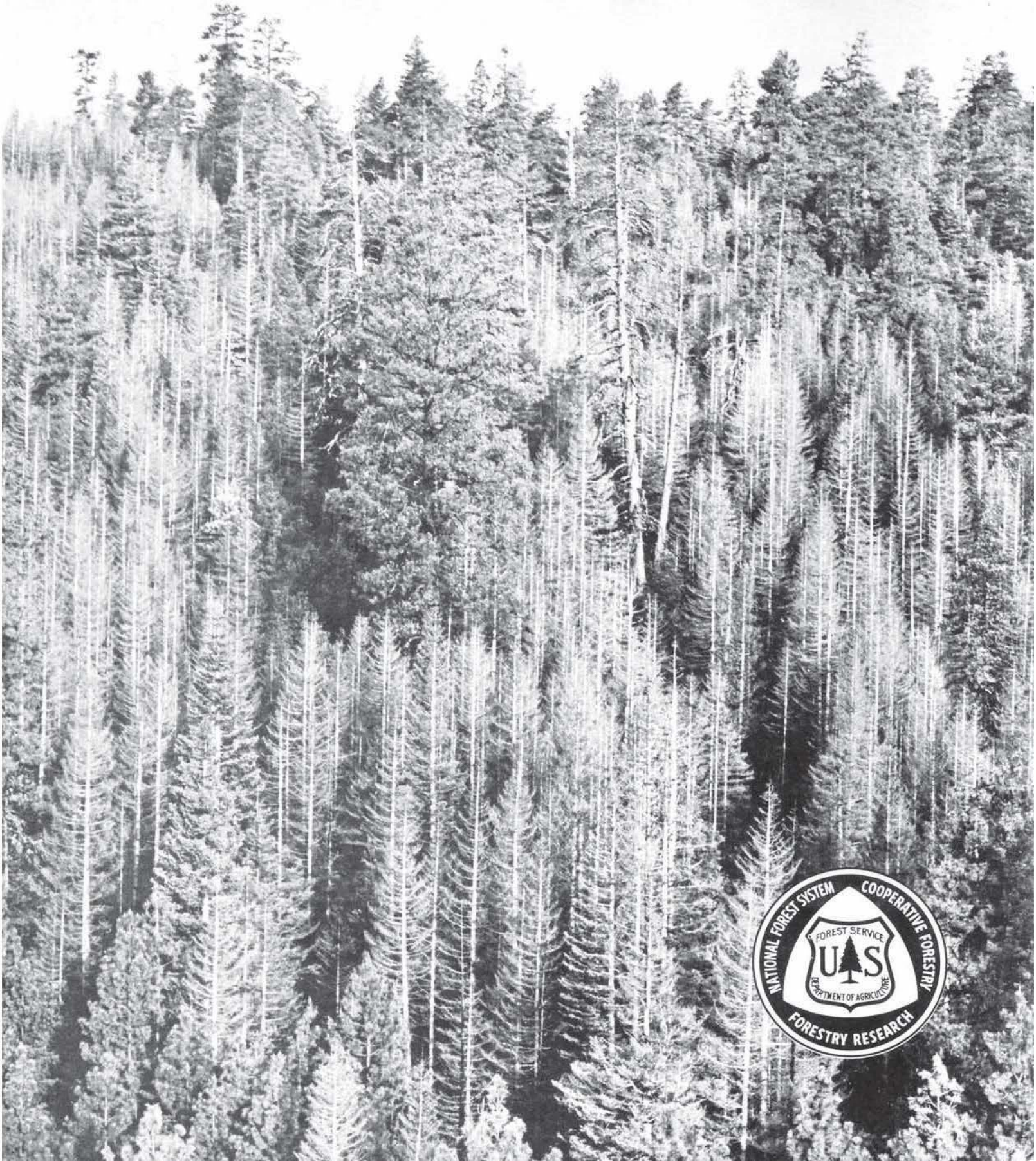
DAILY AVERAGE CUMULATIVE TEMPERATURE



"The Forest Service of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation."

GPO 991-821

BACK COVER: Douglas-fir and true firs defoliated by the tussock moth.


NATIONAL FOREST SYSTEM
COOPERATIVE FORESTRY
FORESTRY RESEARCH
FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE